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Malignant Hyperthermia

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This review is for educational purposes only; always follow your institution's protocols and MHAUS guidelines for the management of Malignant Hyperthermia.

Introduction to Malignant Hyperthermia (MH)

Malignant Hyperthermia (MH) is a rare but life-threatening reaction to certain anesthetic agents, causing rapid onset of hypermetabolism, muscle rigidity, hyperthermia, and metabolic abnormalities. This guide outlines essential protocols for preventing, diagnosing, and managing MH, with a focus on ensuring patient safety in all medical settings.

1. Temperature Monitoring

- All patients undergoing general anesthesia for longer than 30 minutes should have continuous core temperature monitoring.
- This helps identify the onset of MH, as elevated body temperature is a primary symptom.
- The recommended monitoring sites include the esophagus, nasopharynx, tympanic membrane (with probe in contact), bladder, and pulmonary artery.
- Temperature should be closely monitored throughout anesthesia and for some time afterward.

2. Who is Susceptible to MH?

Malignant Hyperthermia susceptibility (MHS) is a genetic condition often triggered by exposure to certain anesthetics like volatile agents (e.g., halothane, sevoflurane) and succinylcholine. Individuals with a family history of MH or known genetic mutations (such as in the ryanodine receptor gene) are at a higher risk. Susceptible individuals should be identified early, either through family history or diagnostic testing.

3. Signs and Symptoms of MH

MH symptoms may develop quickly after exposure to triggering agents. These include:

- Hyperthermia: A rapid rise in body temperature (often above 40°C).
- Muscle Rigidity: Stiffness, often in the jaw and limbs.
- Tachycardia: Increased heart rate, often above 150 beats per minute.
- Tachypnea: Rapid breathing due to respiratory acidosis.
- Hypercarbia: Elevated carbon dioxide levels in the blood, often indicated by increased end-tidal CO2 (ETCO2).
- Metabolic Acidosis: Low blood pH from lactic acid production due to muscle breakdown.
- Myoglobinuria: Dark urine from muscle breakdown (rhabdomyolysis), which can lead to kidney damage.

4. Protocol for Managing MH

The management of MH should be immediate and aggressive. Below is an algorithm to guide healthcare providers:

- Discontinue Triggering Agents:
  Immediately stop all volatile anesthetics and succinylcholine. Switch to non-triggering anesthetics like IV sedatives, narcotics, and non-depolarizing muscle relaxants.

- Call for Help:
  Notify the surgical team, anesthesia staff, and activate the MH crisis team. Call the MHAUS (Malignant Hyperthermia Association of the United States) Hotline at 1-800-644-9737 for guidance.

- Administer Dantrolene/Ryanodex:
  Dantrolene: Given as a 2.5 mg/kg IV bolus through a large-bore IV. Repeat every 5 to 10 minutes if needed. The goal is to reduce muscle rigidity and hypermetabolism. Large doses may be required in severe cases.
  Ryanodex: This newer formulation of dantrolene is more concentrated, requiring only 5 mL of sterile water to reconstitute the 250 mg vial. It is effective in halting the MH crisis but should be administered with caution as it may cause local irritation.

- Hyperventilate with 100% Oxygen:
  Increase fresh gas flow to 10L/min and hyperventilate to flush volatile anesthetics and lower ETCO2.

- Cool the Patient: Core body temperature should be lowered if it exceeds 39°C. Cooling measures include:
  - Cold IV fluids (20 mL/kg of 4°C solution).
  - Ice packing (neck, axillae, and groins).
  - Forced air cooling blankets.
  - Ice-water immersion if available and safe.
  - Caution: Cooling should not be excessive as it may lead to hypothermia. Stop cooling when core temperature reaches 38°C.

- Treat Hyperkalemia and Acidosis:
  Hyperkalemia: Treat with calcium chloride (10 mg/kg), sodium bicarbonate (1-2 mEq/kg), and glucose/insulin (10 units of insulin plus 50 mL of 50% dextrose for adults).
  Acidosis: Administer sodium bicarbonate for base excess greater than -8.

- Monitor and Support:
  Continuously monitor vital signs, including heart rate, core temperature, and ETCO2. Check blood gases and electrolytes regularly. Aim for urine output greater than 1 mL/kg/hr.

- Consider central venous or arterial monitoring for severe cases.

- Transfer to ICU: Once the patient stabilizes, transfer them to a post-anesthesia care unit or ICU for at least 24 hours for continued observation.\

6. Post-Operative Care for MH Patients

Patients who survive an MH crisis should be monitored closely post-operatively. Key indicators of stability include normalized $ETCO_2$, stable heart rate, and resolution of hyperthermia. Monitoring should continue for 24 hours, including:

7. Post-Operative Care for MH Patients

- Core temperature monitoring.
- Frequent blood gas analysis to check for acidosis or electrolyte disturbances.
- Myoglobinuria monitoring (for potential kidney injury).
- Ensuring adequate urine output (>1 mL/kg/hr).

8. Notification of MH Treatment

It is essential to notify the appropriate individuals after an MH event:

- **Family**: Inform the patient's family about the incident and provide guidance on genetic testing.

- **Medical Records**: MH events should be documented, including all medications and interventions used.

- **MH Centers**: Patients who have had an MH crisis should be referred to specialized centers for further genetic counseling and testing.

- **MHAUS**: Report the case to the Malignant Hyperthermia Association of the United States for further guidance and support.

9. Preparing Anesthesia Workstations for MH Susceptible Patients

For MH-susceptible patients, the anesthesia workstation must be thoroughly prepared to avoid triggering agents:

1. **Flush the System**: Follow the manufacturer's recommendations to flush the workstation, typically for 10-20 minutes using high fresh gas flow (10 L/min). This removes any residual volatile agents.

2. **Use Activated Charcoal Filters**: These filters effectively remove trace amounts of anesthetic gases and should be used after the workstation is flushed. They should be replaced every hour.

10. Safe and Unsafe Anesthetics for MH Susceptible Patients

Unsafe Anesthetics:

- Volatile anesthetics: desflurane, enflurane, halothane, isoflurane, methoxyflurane, sevoflurane.
- Succinylcholine (a depolarizing muscle relaxant).

Safe Anesthetics:

- Local anesthetics (e.g., lidocaine).
- Intravenous anesthetics (e.g., propofol, etomidate, ketamine).
- Non-volatile general anesthetics: nitrous oxide.
- Non-depolarizing muscle relaxants (e.g., rocuronium, vecuronium).
- Narcotics (e.g., fentanyl, morphine).

11. Special Considerations:
Pregnant Patients with MH-Susceptible Partners

- For pregnant patients whose partners are known to be MH-susceptible, the management of labor and delivery should be carefully considered.
- The anesthesia team should be informed, and non-triggering agents should be used during any procedures, including labor and delivery.
- While MH susceptibility in the partner does not directly affect the fetus, precautionary measures should be taken.

12. Resources

- **Malignant Hyperthermia Association of the United States (MHAUS)**
  www.mhaus.org
  1-800-644-9737 (for emergencies only)